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Size does matter: City scale and the asymmetries of climate change adaptation in three coastal towns

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ABSTRACT

Globally, it is smaller urban settlements that are growing most rapidly, are most constrained in terms of adaptive capacity but increasingly looked to for delivering local urban resilience. Data from three smaller coastal cities and their wider regional governance systems in Florida, US; West Sussex, UK and São Paulo, Brazil are used to compare the influence of scale and sector on city adaptive capacity. These tensions are described through the lens of the Adaptive Capacity Index (ACI) approach. The ACI is built from structuration theory and presents an alternative to social-ecological systems framing of analysis on adaptation. Structuration articulates the interaction of agency and structure and the intervening role played by institutions on information flow, in shaping adaptive capacity and outcomes. The ACI approach reveals inequalities in adaptive capacity to be greater across scale than across government, private and civil society sector capacity in each study area. This has implications for adaptation research both by reinforcing the importance of scale and demonstrating the utility of structuration theory as a framework for understanding the social dynamics underpinning adaptive capacity; and policy relevance, in particular considering the redistribution of decision-making power across scale and/or compensatory mechanisms, especially for lower scale actors, who increasingly carry the costs for enacting resilience planning in cities.

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1. Introduction

If equity is a consideration of climate change adaptation policy, then investing to enhance adaptive capacity requires approaches that can measure and diagnose its unequal distribution (Ziervogel et al., 2017). The Adaptive Capacity Index (ACI) has been developed to provide a theoretically grounded measurement tool and coupled analytical framework that can help practitioners and researchers surface the negotiated pathways through which adaptive capacity accrues and is deployed within administrative regimes. The tool can be deployed to explore differences between parts of an organisation, between organisations in a community of practice and between sectors in an administrative regime. Analysis presented in this paper works through the tension between administrative scale and the informal relations of this shadow system that work across scale to reproduce uneven speed and level of adaptation.

Small and medium sized cities, with between 300,000–500,000 and 500,000–5 million population (Birkmann et al., 2016) are home to most of the world's vulnerable urban populations and yet have received less research and policy attention than large and mega cities (Wisner et al., 2015). This is a result of limited data, political power, personnel, and resources (Birkmann et al., 2016). Overcoming the disproportionate risk faced by smaller cities is argued to require approaches that can strengthen local organisational and institutional as well as physical and engineering structures – local governance as well as sea walls (Birkmann et al., 2014).

Scale clearly impacts of adaptive capacity and action observed through city size. Within climate change adaptation scholarship and planning, scale is also becoming recognised as a principle

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characteristic that shapes resilience (Sage et al., 2015) disaster losses (Marks and Lebel, 2016) and the governance of disaster risk (Blackburn, 2014). Prevailing critiques present decentralisation, localism and resilience as incomplete governance projects where the shifting of responsibility from central towards local actors has not been accompanied by adequate human or financial resource. Associated with broader critiques of neoliberal state restructuring (Wakefield and Braun, 2014), control is retained in the centre while responsibility is pushed down and out to the local (Coaffee, 2013). Moore (2008) calls for work to move beyond describing to explaining the existence and operation of scalar relations. While accepting these as scaled processes with implications for the distribution of administrative and bureaucratic authority the ACI approach is interested also in reflecting the power organisations and individuals have to work across scales and potentially to flatten scale (Marston et al., 2005) as alliances are brokered to achieve or block adaptation.

Responding to the desire for an indicator framework that can respect both the scaled fixity of administrative systems and the flattening effects of socially constructed and relational interactions between actors we draw from Gidden's structuration theory (1984) and work on shadow systems (Pelling et al., 2008). This allows the index framework to respect the social drivers of adaptive capacity in nested governance contexts. In this case - smaller towns. Here local organisational agency is constrained by higher levels of administrative authority, and both are mediated by informal and formal institutions. The paper presents the Adaptive Capacity Index (ACI) approach and draws out an actor centred analysis of the formation of adaptive capacity in three liberal(ising) administrative hierarchies: Broward County, Florida, USA; Selsey, West Sussex, UK; Santos, Sao Paulo State, Brazil. Broward County and Santos were defined as medium sized settlements while Selsey represented a small urban settlement (Birkmann et al., 2016).

Elsewhere, structuration theory has been deployed to successfully analyse the relationality and power flows between actors and structures in constraining (Pelling and Manuel-Navarrete, 2011) and building (Arnall, 2015) adaptive capacity and resilience. By emphasising asymmetric interactions between actors and their constraining social structures, a structuration lens helps to move beyond the limits of social ecological systems thinking which has tended to steer adaptation research towards an interest in efficiency rather than equity (Taylor, 2015; Brown, 2016). Structuration in this way allows a fixed notion of administrative scale (Hoogesteger and Verzijl, 2015) while recognising the role of relational actions in the performance and practice of scale – through the administration of law, mandate, and budgets.

The ACI (Pelling and Zaidi, 2013) has three components: (1) the index – a quantitative expression of adaptive capacity; (2) qualitative policy review, and (3) an interactive learning tool – respondents can use the conversation through which the tool is delivered to reflect on current practice, goals and procedures. These components are complementary, combining the communicative power of a quantitative index with the more nuanced analytical possibilities of policy analysis and an opportunity for participants to reflect on personal and organisational capacity for change. This paper presents the conceptual and methodological frameworks of the ACI before discussing empirical results and conclusions for building adaptive capacity in small and medium sized cities.

2. Urban scale and adaptive capacity

2.1. Scaled adaptation

To help overcome challenges and barriers to adaptation at a sub-national level, a variety of networks including C40 Cities Climate Leadership Group, Rockefeller 100 Resilient Cities, the Compact of Mayors, and the Regional Learning Network-Latin America have been established. While these networks have been shown to provide opportunities for social learning, knowledge transfer and policy innovation, recent research demonstrates that they are limited as most cities, especially the majority - smaller - cities, lack the institutional architecture (Krellenberg et al., 2014) or resources (Shi et al., 2016; Preston et al., 2010) to participate (Bulkeley, 2010). In this light, the most relevant entry point for work on urban adaptation is that of smaller towns where decision making power is often limited, resources of all types are either restricted or restrictive and yet where expectations and responsibilities for building adaptive capacity to enhance resilience are rapidly increasing (Revi et al., 2014).

There are numerous structural barriers that local authorities face when attempting to mainstream adaptation (Moser and Ekstrom, 2010; Picketts et al., 2014). These encompass events beyond the reach of smaller cities to influence, but that impact greatly on resource levels and governance practices at the sub-national level, such as national policy responses to the global economic downturn of 2008. Economic logics of efficiency or austerity administrative and policy mandates can preference larger cities with greater concentrations of economic and human assets and higher political visibility, effectively isolating smaller and satellite settlements from the policy mainstream (Bentley and Pugalis, 2013; Davies and Pill, 2012). This results in perceptions of abandonment and increased burden at the local level. Policy isolation is compounded for many local governments that also need to respond to the devolved mandate of adaptation which has moved from central to local government responsibility under agendas of localism, decentralisation or self-reliance (Measham et al., 2011; Baker et al., 2012). This movement is often without concomitant transfer of financial or human resource (Gupta et al., 2007; Eakin and Lemos, 2006) and often forces local authorities to examine the trade-offs with other capacities, imperatives, and initiatives that also fall within their mandates such as education, health and social welfare. These trade-offs can not only result in serious justice implications for especially for vulnerable populations, but are often made with incomplete access to data or decision support mechanisms.

In response to these challenges, the production of local level capacity can be seen as a necessary outcome of the lack of support of, and/or lack of capacity within, higher order agencies and institutions. Local capacity reacts to changes in the policy and organisational architecture in which local actors must operate (Dovers and Hezri, 2010). This reactive state in turn establishes the need to assess adaptive capacity as a status that continuously evolves as it devolves across scale. This opens questions on the extent to which organised local action can feedback on higher levels of governance. Analytically, connection points – institutions and practices as well as organisational forms, and asymmetries in power acting across scale in negotiating responsibility for and deployment of adaptive capacity, become important.

2.2. Adaptation as structuration: the interplay of social structure, agency and intervening institutions

Adaptive capacity is a relational property determined by the complex inter-play of multiple scaled variables (Vincent, 2007). The adaptive capacity of collective social systems, such as organisations, depends on their ability to act in common purpose in the face of multiple threats (Smit and Wandel, 2006; Young, 2010). In this understanding, adaptive capacity is determined by the interplay of social structures such as organisational form and function, with the agency of individuals or sub-groups of the social system of interest. Structure and agency coproduce each other

(Giddens, 1984). It is through agency that structure is challenged, reproduced or reinvented; and it is through structure that agency is fostered or contained and directed. Institutions (culture, law, routinsed behaviour) and their disruption are the medium through which structure and agency interact.

The structural aspects of adaptive capacity include the organisational and administrative architecture, external responsibilities and mandate that set the boundaries within which an organisation operates. Interacting closely with structural aspects, agency signifies the scope for local action within a system. Local action can fully materialise goals directed by structure, but can also influence the speed and direction of such goals through foot-dragging, working to rule, corruption or innovation. Multiple actors within a system can project different viewpoints on their own agency and on surrounding social structures potentially resulting in divergent interpretations of adaptive capacity and action, and views on its rationale and legitimacy which can reflect back onto systems level adaptive capacity and even change structural conditions. Learning is a key component of agency that influences the motivations for and direction of adaptive action and capacity building. When social structures and agency do not align the potential for a systems collapse, where a lack of capacity or implementation of formal oversight occurs, and/or a transformative space, where the need for fundamental change in underlying development is realised, often result (Pelling and Manuel-Navarrete, 2011; Fraser et al., 2016).

Fig. 1 summarises the relationship between structure and agency that underlies the ACI method. Each aspect has four dynamics which are coupled, so that structures of technological and economic capital are in a relationship with agency's command over available resources. The individual dynamics of structure and agency interact with one another accepting that adaptive capacity in one area can influence others; changes in technological and economic capital may lead to new demands on social and human capital (Pelling et al., 2015). Internal mechanisms and external forces represent agency and structure. For example, the internal culture and mandate of an organisation (responsibility) is not only moulded by the organisation itself but is shaped by, and helps to shape, the external enabling legislation. This directs analysis to consider organisational adaptive capacity as part of a wider dialectical relationship between organisational agency and structural context. This is important for example in highlighting the degree to which small town (REF) adaptations have been able to inform higher level administrative and legislative structures that would otherwise constrain their ability to cope with climate change impacts. This concept of size and response is examined throughout the cases studies presented in this paper.

The interaction between structure and agency at the level of institutions is captured by the notion of critical self-reflection. Self-reflection distinguishes the ability of individuals, and indirectly of organisations, to reflect on goals, practices and outcomes when faced with the emergent uncertainty and threats of climate change (and higher level policy responses to climate change). Being critical requires evidence of self-reflection that has questioned the practices, mechanisms, processes and even goals of an individual or organisation – not been limited to examining how to improve the effectiveness of existing behaviour. Critical self-reflection can be demonstrated through changes in strategic direction or in the tools or mechanisms used to meet an existing goal. The emphasising of critical self-reflection not only generates data, it also opens an opportunity for participants to self-reflect which carries through the interview process and potentially beyond (Pelling and Zaidi, 2013). Critical self-reflection reinforces the understanding that organisational structures are continuously reinvented, using feedback from environmental cues mediated through social institutions and shaped by the local context of capacity and value (Brooks et al., 2005; Uittenbroek, 2016).

3. The adaptive capacity index approach

The ACI is presented in Fig. 2, this shows the four themes and component sub-themes which guided data collection. These themes are generic qualities of adaptive capacity derived from theory and confirmed in both in previous iterations of the ACI (Pelling and Zaidi, 2013; Zaidi and Pelling, 2013) and during this application through initial discussion with a small group of respondents to make sure that the sub-components were sensitive to local conditions and represented ways of expressing risk and its management. The themes capture two areas of internal procedure (learning and adaptive governance) and two areas of practical operation (risk identification and risk reduction). For application in alternate policy domains other areas of practical operation can be substituted.

Input data were derived from semi-structured, face-to-face interviews. During the interviews respondents assigned a value of performance on a five-point performance scale for each index indicator shown in Fig. 2, and were asked to provide examples of input and outputs for each area of activity represented by an indicator to help justify their assessment of performance. The five-point scale (*Very limited, Basic, Appreciable, Outstanding,* and *Optimal*) was assigned a textual descriptor (see Box 1) and in analysis a numerical value of 1 (*Very limited*) to 5 (*Optimal*). The use of common text and a progressive numerical scale to assess performance

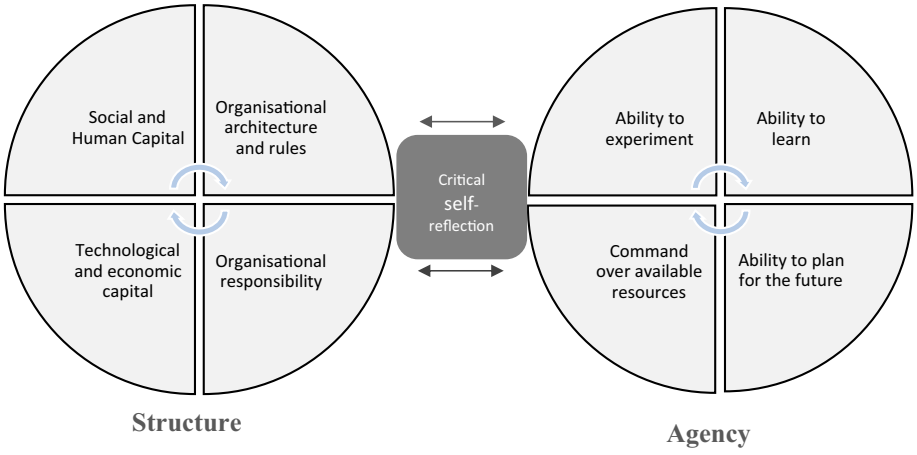

Fig. 1. Conceptual framework of the adaptive capacity index.

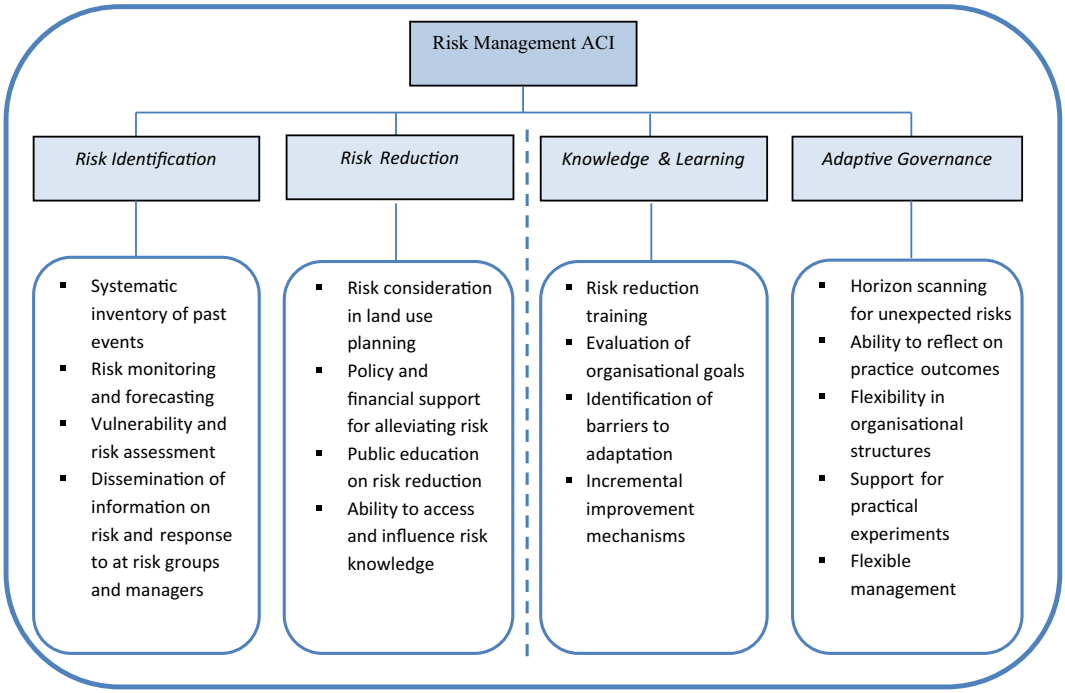

Fig. 2. A risk management ACI.

did not indicate the presence of a universal standard; neither did it imply that the distance between each increment was quantifiable or equal. In practice, the degree of adaptive capacity identified by each respondent was subjective.

Box 1. ACI 5-point assessment scale

Very limited:
No formalised capacity. Activity is ad hoc, very infrequent and not planned or captured by strategy.

Basic:
A low level of formal capacity. Activity is planned. Action is infrequent and superficial, below the levels or intensity required to make a concrete difference to outcomes.

Appreciable:
A modest level of formal capacity. Activity is planned and strategic. Action is regular and outcomes can be identified but are limited in the depth of impact.

Outstanding:
Strong formal capacity. Activity is planned, strategic and integrated into all major sectors. Action is frequent, outcomes have made a clear difference to risk and its management.

Optimal:
Very strong formal capacity. Activity is planned, strategic, integrated and a part of everyday practice. Action is constant, outcomes have reshaped risk and its management and continue to do so in continuous cycles of activity.

The combination of assigned values and exemplifying text allowed analysis to associate performance metrics with potential policy recommendations and for respondents to reflect on their own performance and goals. Because the subjectivity of data collection makes comparison across cases difficult, and to provide a temporal trajectory for each indicator, respondents were asked to assign values and examples of practice for three historical moments. The contemporary assessment for 2015 was supported by assessments for 2010 and 2005. These were chosen because in each case specific political events such as national elections and/or disaster events had occurred that had impacted on risk management policy and practice. Weighting was kept neutral to enhance the transparency and communicative power of the analysis.

To enable analysis across scale and sector, data were collected from organisations across government, civil society and private entities with responsibilities in land use/planning/management, environment, emergency and risk management, transport, energy and water, economy, social structure and health. Sampling was directed through a formal community of practice. For the Broward

County study the community of practice was the Southeast Florida Regional Climate Action Plan (Southeast Florida Regional Climate Change Compact, 2012), for Santos the Preventive Plan of Civil Defence of Santos (Instituto de Tecnologia e Pesquisa, 2012), and for Selsey the Selsey Neighbourhood Plan (Selsey Town Council, 2013) developed in 2013–2014 along with organisations involved in the Medmerry Realignment Project (Gov.UK, 2014). In order to maximise the potential for interviewee response communication brokers were used at each site; Climate UK in West Sussex, the Environmental Protection and Growth Management Department in Broward County, and the Secretariat of Environment and the Civil Defence in Santos. The results presented have been obtained from interviews conducted with 19, 24, and 23 respondents in Selsey, Santos and Broward County respectively.

4. Three smaller coastal towns

Broward County, FL, USA; Selsey, West Sussex, UK; and Santos, Brazil were selected based on identified vulnerabilities to sea level rise and coastal flooding, a mix of critical infrastructure and at risk commercial/residential properties, and willingness to act on behalf of local officials. Across each study the terms national, council, state and city to refer to increasingly local levels of government were used to aid comparison. Administrative jurisdictions for each level are shown in Box 2.

Box 2. Governmental Scale Nomenclature

Selsey
City= Local authority, Town/Parish Council
County= District and County Councils
National = Central government

Santos
City = Municipal government
State = São Paulo state government
National = Federal government

Broward County
City = Local authority, city mayor's and managers
County = County government
State = Florida
National = Federal government

Broward County's tourism and industrial activities sit alongside large critical infrastructure such as Port Everglades and the Fort Lauderdale-Hollywood Airport. While the County is dominated by the large city of Fort Lauderdale, the smaller cities of Hollywood and Dania Beach were also included in the study area. It is also recognised that Florida is considered one of the most vulnerable areas in the United States to climate change with Southeast Florida at high risk to sea level rise. Selsey, West Sussex, is located on the south coast of the UK on the Manhood Peninsular, and is encompassed by Chichester District Council. The town's main socio-economic drivers include tourism and elderly care home provision. Prior to the construction of sea defences in 1956, the Selsey peninsula was one of the most rapidly eroding shorelines in the UK. Efforts to slow this erosion and protect the town, resulted in the construction of a series of groynes and a sea wall. Santos, São Paulo state, is the seat of the Metropolitan Region of Baixada Santista and hosts the largest commercial port in Latin America accounting for more than a quarter of all goods entering and leaving Brazil.

In each site, policy and planning landscapes are multi-layered, with multiple actors, responsibilities, decision-making processes, capital programmes, and priorities that are, at times, in direct conflict. In Broward County the landscape is further confounded by the addition of self-managed entities such as Port Everglades and the Fort Lauderdale/Hollywood International Airport as well as the obvious economic drivers of private sector organisations. Lacking state-wide political governance vision or support, the Southeast Regional Climate Compact (SRCC), a voluntary and cooperative partnership among local governing bodies in four Counties including Broward was launched. While the SRCC has a vision of inclusion, the reality suggests that the agenda is primarily directed by the counties and several large cities. All cities and towns within the County are tasked with the development of comprehensive or master plans in addition to the planning efforts at the County level.

In the UK, national adaptation policy is directed by the Climate Change Act (2008), the Committee on Climate Change and technical actions through the Climate Change Risk Assessments Act (2012) and National Adaptation Programme (2013). While relevant actors range from the Environment Agency that has strategic overview role for all matters concerning flood defence on the coast and on designated main rivers, to the West Sussex County Council the designated Lead Local Flood Authority (LLFA) with responsibilities to prepare and maintain the local flood risk management strategy, as well as local businesses and service providers, the planning landscape is primarily dictated at the national level. Key legislative policies such as the Localism Act (2011) and the Flood and Water Management Act (2010) have increased local responsibilities for resilience and adaptation planning and action.

Santos has no municipal legislation for adaptation but is governed by a number of national and state laws. São Paulo State was an early adopter, launching a climate change policy in 1995 and 2009. Federal law states that project financing must demonstrate long-term benefits including social as well as economic gain (Krellenberg et al., 2014). In 2015 Santos established a Municipal Commission for Adaptation to Climate Change to develop of the Municipal Plan for Adaptation to Climate Change, a direct consequence of Metropole Project.

5. Assessing adaptive capacity across scale and sector in smaller cities

5.1. The adaptive capacity of risk management regimes

Across these three smaller cities, the greatest difference in adaptive capacity was the variable speed with which capacity was built. Santos and Broward County demonstrated consistent and progressive increases in adaptive capacity between 2005 and 2015 while Selsey showed more limited and irregular progression (Fig. 3). Broward County recorded the most rapid increase in self-reported adaptive capacity with a 2-level improvement from *very limited* with no formalised capacity and ad-hoc activity to *appreciable* with a modest level of formal capacity and strategic and planned activity for most indicators over the decade under examination. Although overall respondents from Santos returned higher results, closer to *outstanding* (strong formal capacity with integrated and strategic planning across sectors) in many components, the distance between previous and current conditions was not as marked as observed in Broward County. Selsey showed both limited self-reported improvement over time and a low level of AC. However, improvements in the components of 'command over available resources' and 'organisational responsibility' were noted, shifting from *very limited* to *basic* in each case.

Why does the speed and level of adaptive capacity vary across these urban centres?

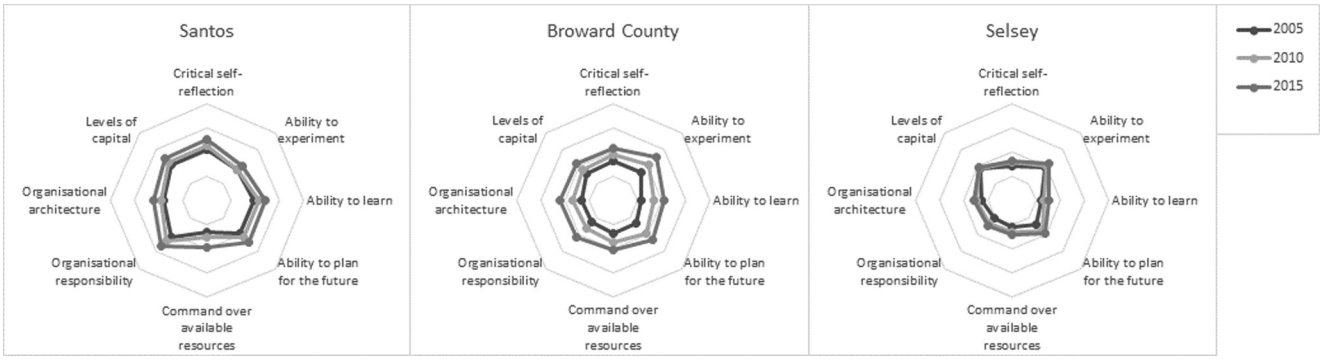

Fig. 3. Overall adaptive capacity results for the three study sites. Note: the centre of each octagon indicates very limited capacity, with capacity rising to optimal in the outer ring.

In Broward County, three external pressures were identified as shaping adaptive capacity over the last decade: (i) the 2008 global economic downturn, (ii) the establishment of the SRCC in 2009, and (iii) strategic decisions made specifically by Fort Lauderdale surrounding planning initiatives and a shift in personnel hiring policy at the city level in response to knowledge generated through involvement in the SRCC. The first two events had mixed consequences. They affected government agencies and private sector organisations differently in terms of shifting access to resources and degrees of influence for risk management. The third pressure was described as a strongly positive influence on adaptive capacity and to have driven subsequent progression.

In Selsey, respondents highlighted economic depression resulting from the global economic crisis and legislative changes as pressures for a range of impacts, most prominently the devolution of responsibilities for risk management from central government to local authorities. Devolution marked by a re-structuring of central government agencies and a perceived reduction in technical and financial support available to local councils such as Selsey. Local actors saw opportunity for self-determination in decentralisation but expressed concern about existing capacities to respond to retreating central provision and the growing local mandate and expectation for risk management. This was expressed by respondents describing the resulting capacity as stagnant.

In Santos, lack of progression across the components of the adaptive capacity index from the perspective of local actors was accounted for through: (i) a lack of organisational integration and (ii) the dominance of the adaptation agenda by Civil Defence. This suppressed leadership and innovation especially between agencies. Global economic pressures were also felt by Santos. While the global economic downturn of 2008 had a limited effect on the Brazilian economy at the time, greater impacts were noted post 2014 with more constrained resources and funding opportunities reported across all sectors and agencies. Together these pressures served to hold Santos' adaptive capacity.

5.2. Adaptive capacity across sectors

Between government, private and civil society sectors, civil society actors showed the greatest variability in adaptive capacity. This suggests both greater susceptibility and responsiveness to the changing conditions of risk and adaptation. In Broward County, civil society actors reported positive but uneven growth in adaptive capacity. Selsey and Santos showed stagnation over the reported decade but with large variation in ACI components over the 5-point scale (Fig. 4).

Respondents returned similar narratives for the shape of ACI in the governmental sector, but different explanations in the civil and private sectors. In Broward County, adaptive capacity in the local civil sector was boosted by the involvement of international NGOs, such as The Nature Conservancy, with access to extensive financial and technical resources. The sector was also unrestricted by recent political agendas that had constrained government actors in Florida, particularly at the State level. This was reflected in a noticeable change between each ACI component at each time period. In March 2015, extensive negative press was generated surrounding the ban of use of the term 'climate change' in government agencies in State of Florida allegedly based on Governor Scott's demands (e.g. http://www.huffingtonpost.com/2015/03/12/rick-scott-climate-change_n_6855006.html, http://www.miamiherald.com/news/state/florida/article13576691.html). This revealed a disconnect between efforts at the County and city level and the larger scale State level with longer term implications for financial and human resources, as well as greater restrictions being placed formal collaborations and relationship development.

The civil sector in Selsey returned low scores across most index components despite providing examples that demonstrated activity. This suggests that although many actions taken had a positive impact on adaptive capacity, these were often very localised. NGO respondents in particular reported feeling limited by central government actions and by increasing levels of European legislation. Several organisations expressed concern at the increased redirection of time and resources needed to lobby for legislative changes at these higher levels, rather than focussing on their own priority work areas. This constrained ability to make strategic decisions that could have enhanced adaptive capacity. Civil sector respondents in Santos highlighted that constraining legislation, government agency re-structuring and a lack of integration across the risk management regime had made it difficult to initiate experimentation and new learning for adaptation.

The private sector showed a very different picture in each site. In contrast to other sectors, the private sector in Broward County returned very constrained and limited ACI results, with little change over time. However, in Selsey, driven by necessity borne out of central government retreat and changing legislation, the private sector had built high levels of adaptive capacity across several components such as the 'ability to plan for the future'. This was typified by a £16 million of privately constructed sea defences to defend one particular existing economic interest at West Sands Beach. However, the overall constraints seen in Selsey surrounding organisational architecture and responsibility were revealed as a lack of collaboration between the private and governmental sectors resulting in conflicting rather than complimentary actions. In Santos, the private sector expressed high levels of adaptive capacity across many components with the exception of 'command over available resources'. This suggested that adaptive capacity and the development agenda in Santos was driven much more by the private sector than either the civil or government sector. The privati-

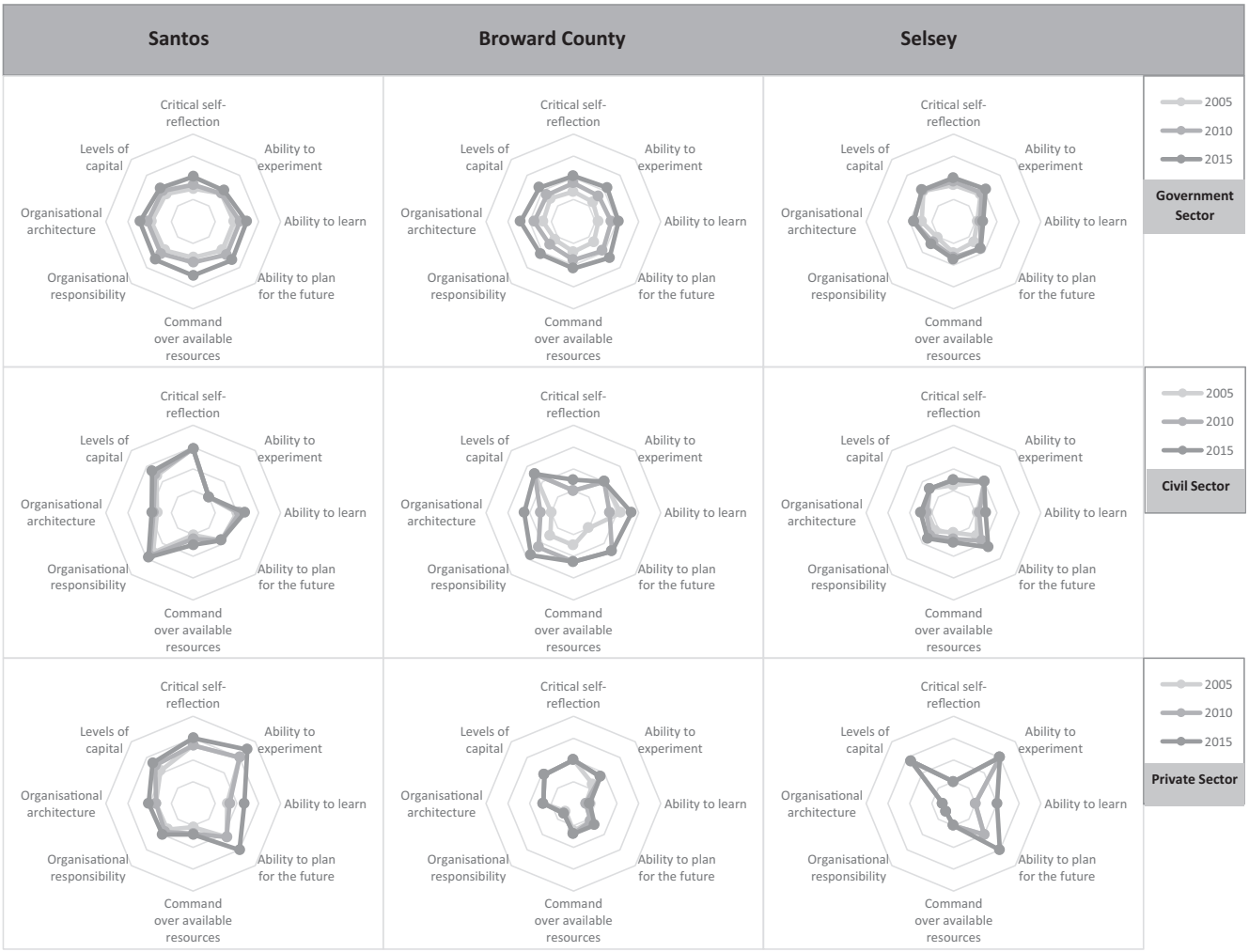

Fig. 4. Disaggregated adaptive capacity results by sector for all three study sites. Note: the centre of each octagon indicates very limited capacity, with capacity rising to optimal in the outer ring.

zation or contracting out of municipal services resulted in fragmented communication between different agencies, utilities and the city administration, reducing overall capacity to deal with the local effects of climate change.

5.3. Adaptive capacity across scale

Disaggregation of results by scale of government actor is presented in Fig. 5. Across all three sites higher level government agencies demonstrated high levels of adaptive capacity, with limited or no shift over time. This likely reflects the rigidity of larger administrative units. In Selsey, the greatest shifts over time were found at the middle order or county government level. This was a response to the devolution of responsibilities from central government. However, those demands had not filtered down to the local level, generating a disconnect between these levels of government in resources and support for change. In Broward, positive progression was noted at both the county and the local levels. The opening of space for knowledge exchange created by the SRCC was noted by respondents as the biggest driver for this advance. In Santos, regional government demonstrated limited changes in adaptive capacity over time with the biggest shift at the city level. Respondents associated these increases, especially for the time period between 2010 and 2015, with an extensive investment in risk management and adaptation in response to major disaster events that occurred in the region between 2008 and 2011. This resulted in legislatively-driven changes of several key organisations, particularly Civil Defence, opening policy and bureaucratic space for organisational change.

6. Adaptive capacity at the intersection of agency and structure

This section presents four mechanisms operating at the intersection of agency and structure to account for the differential scaling of adaptive capacity across the three cases: (i) problem framing and ownership, (ii) information access and interpretation, (iii) resource availability, and (iv) governance spaces and networks.

6.1. Problem framing and ownership

Problem framing arose from the institutionalisation of the values and aims of dominant policy actors within a specific regime. This shapes the social processes through which vulnerable objects, forms of risk, acceptable actions and those stakeholders with a voice are identified, evaluated and implemented. (O'Brien et al., 2007; Wise et al., 2014). Framing also influences the legitimacy of actors through organisational responsibilities, job descriptions and enabling legislation. Problem framing acts on many scales providing opportunities for strategic planning and engagement efforts, re-framing can encourage the involvement of new actors

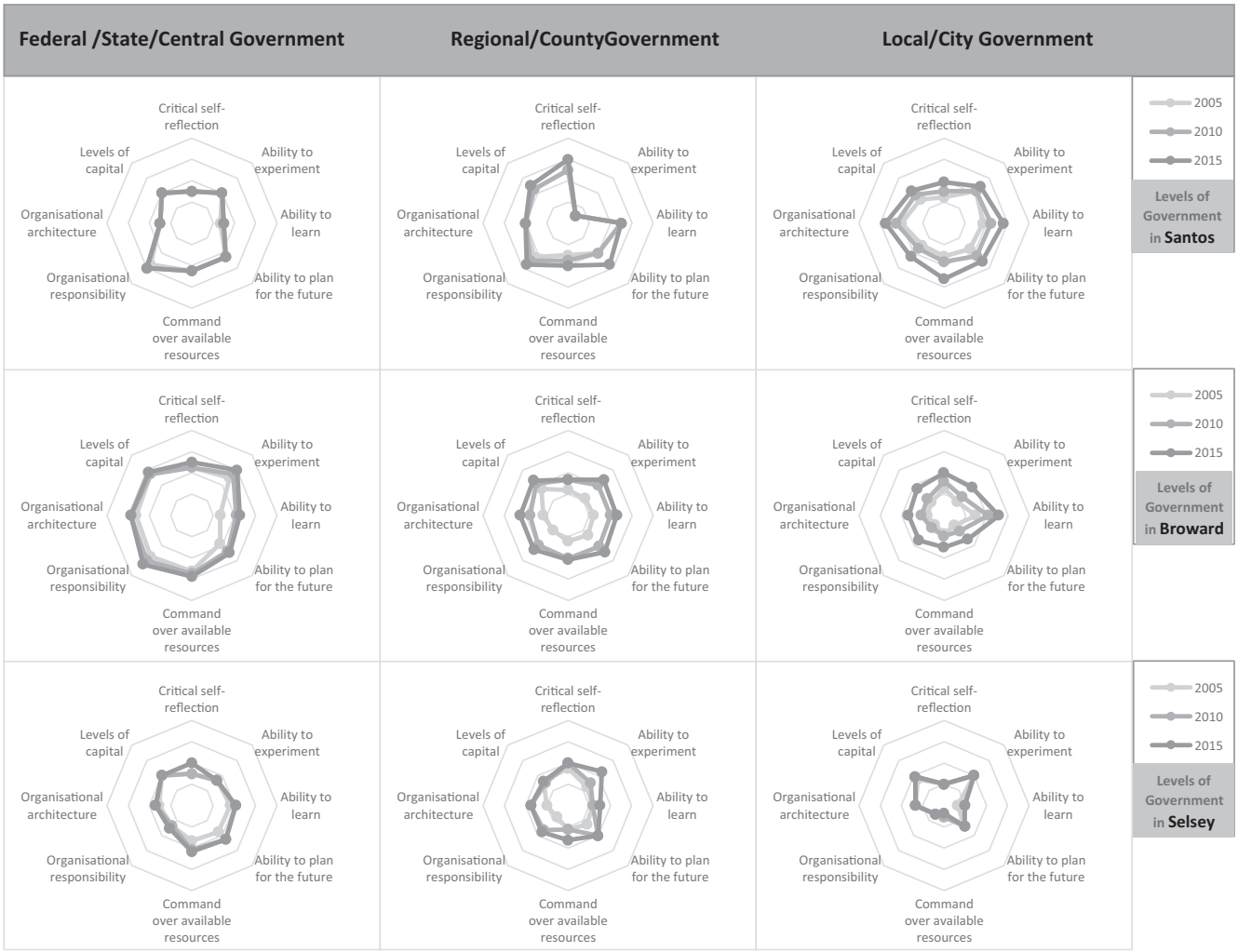

Fig. 5. Disaggregated adaptive capacity results by level of government in all three sites. Note: the centre of each octagon indicates very limited capacity, with capacity rising to optimal in the outer ring.

and new collaborations between risk managers, management agencies and across the civic and private sectors (Dewulf, 2013).

The establishment of a highly structured and potentially inflexible frame, especially at a high level, can force local actors to innovate and experiment in order to find ways of engaging productively with that frame. In Selsey, all levels of government had responsibilities to engage with climate change through adaptation and resilience initiatives, in many aspects, they were legally obligated to do so. West Sussex was required to prepare a Local Flood Risk Management Strategy where planning efforts were conducted in partnership with the Environment Agency, district and borough councils, water companies, Regional Flood and Coastal Committees and Internal Drainage Boards. This cross-sectoral engagement ensured the incorporation of a variety of social values into planning efforts and increased potential engagement and implementation even when central government was decentralising responsibility without capacity.

Ownership of the narrative surrounding climate change adaptation and risk management has been shown to influence the organisational architecture of a risk management regime and its attendant distribution of responsibilities and resources (Tompkins and Adger, 2005; Wise et al., 2014). Ownership often dictates how power is distributed across a landscape as well as the legitimacy of actions taken (Cannon and Müller-Mahn, 2010). In Santos, the dominance of a single public sector actor - Civil Defence – in the imagining, institutionalisation and implementation of formal adaptation policy had a constraining effect. This was reflected in a lack of recognition of climate change issues by other organisations across the risk management regime and only cursory integration between the Civil Defence and other sectors. The lack of comprehensive participation in climate change risk and adaptation problem framing and ownership constrained adaptive capacity in the city, making it difficult for organisational aims and structures to evolve with emerging risks.

6.2. Information access and interpretation

Control over the creation, analysis and communication of information and data is a key function of problem framing, the ownership of adaptation policy and in creating solutions. At the local authority level, there was often great frustration attached to the limited data available for an informed decision-making process. This reaction was not limited to responsible local government actors, but also to members of the private sector who had begun to engage with climate change adaptation. Bridging the gap between national and local capacities therefore remained a common challenge. In Broward County, the functions of planning and implementation were separated between County Departments and the South Florida Regional Planning Council officials and local city officials. The control of data and interpretation by County

officials generated mistrust and misinterpretation of planning guidance and strategy at the local city levels where base data were not easy to access or interpret.

Access to information can be viewed as a function of the engagement process with any restrictions in data access a potential breach of procedural justice. A desire for sustained participation of residential groups and the public in data access and interpretation was consistently flagged by respondents in Selsey as one of the major challenges facing local actors. Multiple respondents called for improvements not just in access to data but also access to the decision-making processes and organisations that created, analysed and used data as a necessary step if local government and through them the public were to be meaningfully engaged. As central responsibility for risk management is withdrawn and local government capacity remains constrained it is likely risk management responsibility will only grow for individual citizens, businesses or representative civil society organisations. Shifts from publically funded sea-defences to privately funded flood-proofing and insurance require local access to information and its analysis which is not currently in place. The effectiveness of local collective action in the face of changing climates is strongly dependent on networks and flows of information between individuals and groups (Adger, 2003) across formal and informal circuits (Pelling and High, 2005) with local networks and associations, and the relationships and patterns of reciprocity and exchange, being paramount to building adaptive capacity (Bentley and Pugalis, 2013). This suggests that a focus on the mechanisms for and degree of stakeholder engagement to go beyond information dissemination to meaningfully enable the co-production of policy at the local level is needed to allow local adaptive capacity to escape from its responsive mode to a retreating state, towards a vehicle for enabling local self-determination.

6.3. Resource availability

While global and national economic trends and austerity measures played a notable role in the availability of financial and by extension human and technical resources at the local level, this was exacerbated by simultaneous changes in responsibilities. Efforts to devolve responsibilities for climate change adaptation actions to local government levels through legislation such as the Localism Act 2011 (UK) reinforced the need for a greater level of adaptive capacity at that local level. However, stated lack of resources forced local authorities to examine the trade-offs with other capacities, imperatives, and initiatives that also fell within their mandates such as education, health and social welfare. Each city also recognised the unobtainable level of investment needed to climate proof critical infrastructure such as water and wastewater infrastructure in Broward County, the seawall in Selsey or drainage canals in Santos. Both these factors manifested differently in each city and led to specific adaptations to access funding.

In Broward County, responsibility for long term adaptation planning lay with the County administration with an anticipated increase in responsibilities locally as planning efforts morph into a period of implementation. With cities in the County being responsible for many diverse systems such as transport, housing, utilities and coastal defence, smaller cities were faced with rapidly rising costs of upgrading infrastructure when budgets were already stretched beyond capacity. A possible but maladaptive strategy proposed was to raise local authority tax income through high value coastal development (e.g. high density or high standard residential and commercial development on the coast front). The SRCC has been identified as a potential avenue for joint federal funding applications that could be used at both the regional and the local level. The development of such a strategy presents a tempting opportunity for the region as a mechanism to ease the impacts of the responsibility devolution without resources conundrum that often impacts adaptation efforts in smaller scale cities.

While resource availability remains a key constraint to adaptation, resource deployment resulted in two innovative pathways operating at different scales in Selsey. First, Selsey Town Council recognised that it would need to co-fund any future coastal defence infrastructure and large scale protection schemes with the Environment Agency. This is a legal requirement acting on the Environment Agency which has responsibility for coast defence in England. The need for financial contributions has led Selsey Town Council to ring fence funds specifically for improvement work on the existing sea defences. This decision alone demonstrated a high degree of adaptive capacity, with the willingness to modify organisational structures and adaptation goals as well as planning for the future being taken internally, rather than being imposed from above. Second, in response to funding limitations, private investment in coastal protection schemes has already been observed. The potential for public/private partnerships, or private led adaptation represents a major opportunity for the Selsey area if momentum can be maintained through local action. Implications for equity are unclear requiring further research as coast defence funding moves towards private financing in the UK.

In Santos, respondents consistently identified lack of financial resources as a barrier to risk management, especially lack of flexibility and slow disbursement of resources to the city from state and central government agencies. Hampered by a heavy administrative system, in this case bureaucracy reduced the adaptive capacity of the municipality. This was manifest in a reluctance amongst managers to invest their scarce time and resources to develop funding requests for adaptation projects. This constrained experimentation within the city and within key organisations.

6.4. Governance spaces and networks

Spaces for learning are simultaneously cultivated in the formal (canonical) and shadow or informal systems of relationships, networks and spaces that compose social collectives including organisations (Pelling, 2011). The interaction between the shadow and canonical and especially how far the canonical can tolerate the shadow without losing key performance goals such as transparency and efficiency is a key dilemma and threshold point for adaptive capacity (Pelling et al., 2008).

The importance of shadow spaces was regularly noted by respondents in all study sites. Many respondents stated that access to data and information was tied directly to personal relationships. In Broward County, the overwhelming perception was that adaptation efforts and levels of adaptive capacity would have stagnated in the region if it were not for individual relationships and informal avenues of collaboration in the face of institutional and political blockages. Two factors enabled thick shadow systems. First, many individuals had remained in positions of technical authority and influence in the County and city arenas even when they had moved jobs, allowing a continuity of network to be maintained. Several individuals had moved from County to city, from city to city in southeast Florida, from city to Federal agency based in the Florida but retained similar functions in their new positions providing opportunities for continued engagement with the same colleagues and professional networks as before reinforcing existing ties and providing a productive shadow space in which to operate. Second, the strategic employment of certain individuals in key positions created a culture of action-mindedness despite the very real presence of barriers at the State and National levels. The best example of shadow spaces was found in the development and success of the SRCC which was driven by individual action and not by formal legislative efforts. This does however create the possibility of a dual system where personalities are the basis of interaction and not

organisational structures or policy mandates. The fear within smaller cities is that individuals will prioritise personal relationships above the region's needs distorting adaptation and becoming a potential source of conflict with the SRCC.

While the use of the shadow system was consistently regarded as 'the norm' in all three study sites, in contrast to Broward County, both Selsey and Santos highlighted limitations caused by regular restructuring and modification of job descriptions and responsibilities within government agencies. This created instability in employment and organisational structure with increased feelings of isolation and disconnection within and between hierarchical levels. When the shadow system was eroded and key communicators within it had been reduced to formal relationships, dialogue between organisations was perceived to have become stilted and less effective. With trust in the formal network limited, especially locally, and local capacity considered almost non-existent by higher order organisations. The shadow system remained vital to forwarding the adaptation agenda across the risk landscape. However, the perceived instability and dynamic nature of council officers and national agencies meant that the already fractured landscape became even more difficult to operate in.

The shadow system is considered by some too complex to explore and regularly seen as a source of corruption and inefficiency that requires greater management and control (High et al., 2004). These cases demonstrate the opposite. The shadow space was part responsible for shifts in organisational and governmental capacity resulting in the potential for adaptation in the case study sites. More work is needed to understand shadow spaces and institutions that contribute to the potential opportunities and limitations of adaptation provided by the interweaving of shadow systems with canonically institutionalised social structures (Agrawal, 2010; Ostrom, 2014). For small towns with populations below 500,000, where close personal relationships often form the basis for interaction, this is arguably a priority for policy consideration. The landscapes of small town governance systems offer a microcosm in which to develop a greater understanding of informal spaces and institutions that contribute to the potential opportunities and limitations of adaptation provided by the interweaving of shadow systems with canonically institutionalised social structures.

7. Potential limitations

Resilience planning means that local organisations in many locations are now faced with the prospects of having to take on the burden of adapting to allow stability in higher order organisations (Vincent, 2007). This same logic is further emphasised by austerity induced localism and decentralisation (Raco and Street, 2012). While local actors, exemplified in this study by small towns, experience an overall loss of capacity, decentralisation was associated with experimentation and revised inter-organisational relationships aimed at better knowledge transfer and learning. Such local adaptations can be interpreted as indicating a shift in the social contract between residents and local authorities on the one hand and central authorities on the other. This comes from the local realisation that central government is no longer prepared to fund or support local infrastructure at the same level as previously seen. This provides detailed empirical support for more theoretically derived claims that resilience and adaptation have led to burden-shifting for risk management towards the local, with a weakening of equity in development (Engle, 2011).

Is there an adaptation trap that results from this new emerging social contract? Might it be that adaptation, in shifting the burden of risk management to the local and ultimately the individual, misses an opportunity to be part of a wider project of development and public policy that can redistribute wealth and opportunity – including safety? Lessons from disaster risk management highlight this possibility and the challenge of piecemeal, localised resilience that accentuates rather than helps to overcome wider social inequalities. By combining an analytical and normative framework the ACI provides both a way to understand and mechanism for practitioners to reflect on contemporary structures, values and behaviours that shape adaptive capacity including across scale. This creates the opportunity for purposeful adjustment and reform, potentially of transformation (Pelling, 2011; O'Brien et al., 2012).

8. Conclusion

The scaled property of adaptation is confirmed in this study which deploys a relational framework rooted in structuration theory to draw out actor-structure interactions in the formation and deployment of adaptive capacity. Scale sits alongside inequality expressed through policy sectors, geographical location, social class and other social characteristics. It is though, a quality of social life that has not yet been a core focus of adaptation research.

The ACI approach offers a concrete interpretation of structuration theory, one that is nuanced through the relational lens of shadow/canonical systems. The ACI offers a standardisable methodology through which to reveal and monitor interactions between actors, structures and mediating institutions. In this case to reveal the pathways through which inequality of capacity is articulated through scaled relations within small and medium sized urban settlements. The cases studied here have shown how scaled inequalities in adaptive capacity were reproduced through the action of local as well as non-local actors and became institutionalised at local and non-local scales in administrative responsibility and routinized behaviour. We find extra-local actors to have been dominant in this reproduction of inequality, but that scope existed for local actors to assert agency and influence outcomes. The extent and effectiveness to which local agency was asserted varies considerably. In Santos perceived transactions costs constrained local adaptive agency. In Selsey actors who had become aware of structural inequality through the ACI have since organised local collective action to voice concerns and consider joined-up action including information sharing between small coastal towns.

That scale may be a primary factor in the assessment of equity in adaptive capacity opens a range of questions for policy and research. Might it be that local action targeted at the local structures that produce inequality can impact on extra-local structures and initiate transformative adaptation? If so what kind of action is most effective? How can the interaction between structure and agency across scales best be fostered to enable local voice and leadership? What checks and balances are needed to enable local capacity without powerful interests distorting processes? Political ecology approaches have explored scale and justice in natural resource management (Taylor, 2013), but this insight has not yet been fully brought to bear on the emerging politics of adaptation. By providing a conceptual and methodological approach through which to reveal the scaled inequalities of adaptive capacity the evidence reported here establishes the need for these tools to be deployed and in ways that policy actors can reflect on desired futures.

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